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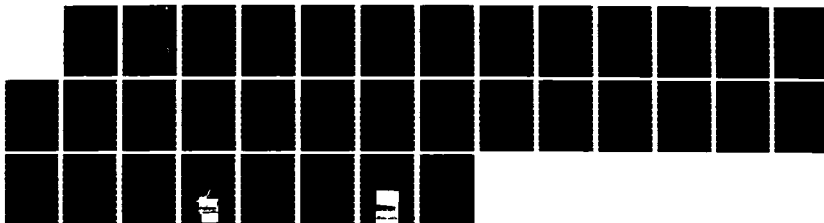
CENTRIFUGAL CONSOLIDATION TESTING OF SOFT SOIL(U)
GIBSON (ROBERT E) FERRING (ENGLAND) R E GIBSON 1986
DAJA45-85-M-0533

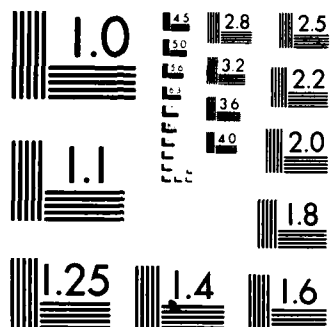
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CENTRIFUGAL CONSOLIDATION TESTING OF SOFT SOIL

(being the Final Report to U.S.A.R.D.S.G.-U.K. under
Contract No. DAJA45-85-M-0533 and Requisition R&D 4933-EN-01/A)

1. INTRODUCTION

The objective of ^{this} ~~the~~ research ~~undertaken~~ is to provide physical modelling data which will enable the validation of existing theory and/or will provide data to permit empirical correction factors to existing theories which will model field geometries. → (+) R

The first Interim Report described a pilot centrifuge model test (Test #1). The second Interim Report described two additional tests (Tests #2 and 3) and the data was reported. This Final Report the last two tests of the series are reported (Tests #4 and 5).

The intention of these series of tests was to model the self-weight consolidation process of a soft clay in which the deformation in the direction of gravity is dominant while the flow of water is free to occur in both vertical and lateral directions.

2. Test #4

Test #4 was conceived as benchmark test in which only one dimensional (vertical) water flow is allowed. Thus the comparison of the test results of other tests with the results of this test will provide information regarding the influence of the lateral draining on the consolidation process.

2.1 Model Container

The same model container as in the previous tests was used in this test. However, there was no lateral porous stone in this test so that the water drainage was only in the vertical direction.

2.2 Material Characteristics

The same material as in the previous tests was used.

1

2.3 Model Preparation and Testing

The model preparation and testing procedure was identical to those used in the previous tests. This test lasted for 10.5 hours.

2.4 Test Results

The test results showing pore pressures and settlements are presented in the attached Figures. The changes in pore pressure with time at the three pore pressure parts are presented in Figure 1. The measured values are consistent indicating almost identical dissipation pattern for all three measuring parts. Since the test was really one-dimensional such a response was anticipated.

The changes with time of the model height are presented in Figures 2 through 8 for scales 1 through 7. Corresponding settlement are presented in Figures 9 through 15 using an arithmetic time scale and Figures 16 through 22 using a logarithmic time scale. Figure 26 summarizes the results of the surface settlements.

A photograph of the model in flight is shown in Figure 23. It shows uniform settlement of the whole surface.

At the end of the test the material was sampled at five locations in five layers. The void ratio distribution is presented in Table 1.

Table 1
VOID RATIO DISTRIBUTION AFTER TEST #4

	A	B	C	D	E
1	2.76	2.81	2.58	2.66	2.55
2	2.48	2.46	2.39	2.36	2.36
3	2.34	2.34	2.33	2.26	2.25
4	2.19	2.20	2.22	2.19	2.13
5	2.12	2.12	2.17	2.15	2.11



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3. Test #5

Test #5 was designed to provide two additional pieces of information not available from the previous tests. First, an attempt was made to obtain a complete deformation picture of soil elements in the vicinity of the drained lateral boundary and second to obtain pore pressure history at a point very near the porous drainage plate. The deformation measurements were to be taken by observing deformations of an embedded grid consisting of flexible noodles.

3.1 Model Container

The same container as in previous tests was used except for the position of the porous plate. Schematic drawing is presented in Figure 24 in which the porous plate position is indicated.

3.2 Material Characteristics

The same material as in the previous test was used.

3.3 Model Preparation and Testing

The model preparation and testing procedure was identical to those used in the previous tests. This test lasted for 9.5 hours.

3.4 Test Results

In this test only data indicating the pore pressure changes with time were obtained. There are presented in Figure 25 for all three pore pressure measuring parts. The camera for taking still photographs was focused on the area near the porous plate, thus not all the scales were visible. The vertical and horizontal noodles in this test deformed in a random fashion and no coherent deformation pattern could be detected. A photograph showing the noodles' position in flight is shown in Figure 26.

After the test the material was sampled at five locations in five layers. The void ratio distribution is presented in Table 2.

Table 2
VOID-RATIO DISTRIBUTION AFTER TEST #5

	A	B	C	D	E
1	2.58	2.61	2.82	2.72	2.50
2	2.40	2.45	2.54	2.46	2.34
3	2.27	2.32	2.42	2.34	2.26
4	2.23	2.25	2.29	2.25	2.20
5	2.20	2.22	2.25	2.15	2.15

4. CONCLUSIONS

The executed testing program provides sufficient information to make the following conclusions:

- 1) The centrifuge modeling technique proved to be a powerful tool for studying the influence of lateral drainage on the consolidation process of soft material.
- 2) The pore pressures dissipated faster in the vicinity of the lateral porous plate. The combined pore pressure dissipation data from tests 2, 3, 4 and 5 provide a complete picture of the pore pressure distribution at the bottom of the consolidating layer.
- 3) The influence of the lateral drainage on the pore pressure diminishes at a distance of approximately 4" for the model tested which corresponds to 1.3 times the initial height of the consolidating layer.
- 4) Settlements progress faster in the vicinity of the lateral drainage plate but the ultimate settlements are the same indicating that no significant side friction developed.
- 5) Though the external lateral deformations were prevented with the rigid porous plate the internal deformations in the horizontal direction were significant in the vicinity of the vertical drained boundary.

6) Only a numerical analysis of the performed tests could answer the question about the importance of the observed lateral deformations. Their influence on the overall consolidation process could also be evaluated in the case that a complete analysis is performed.

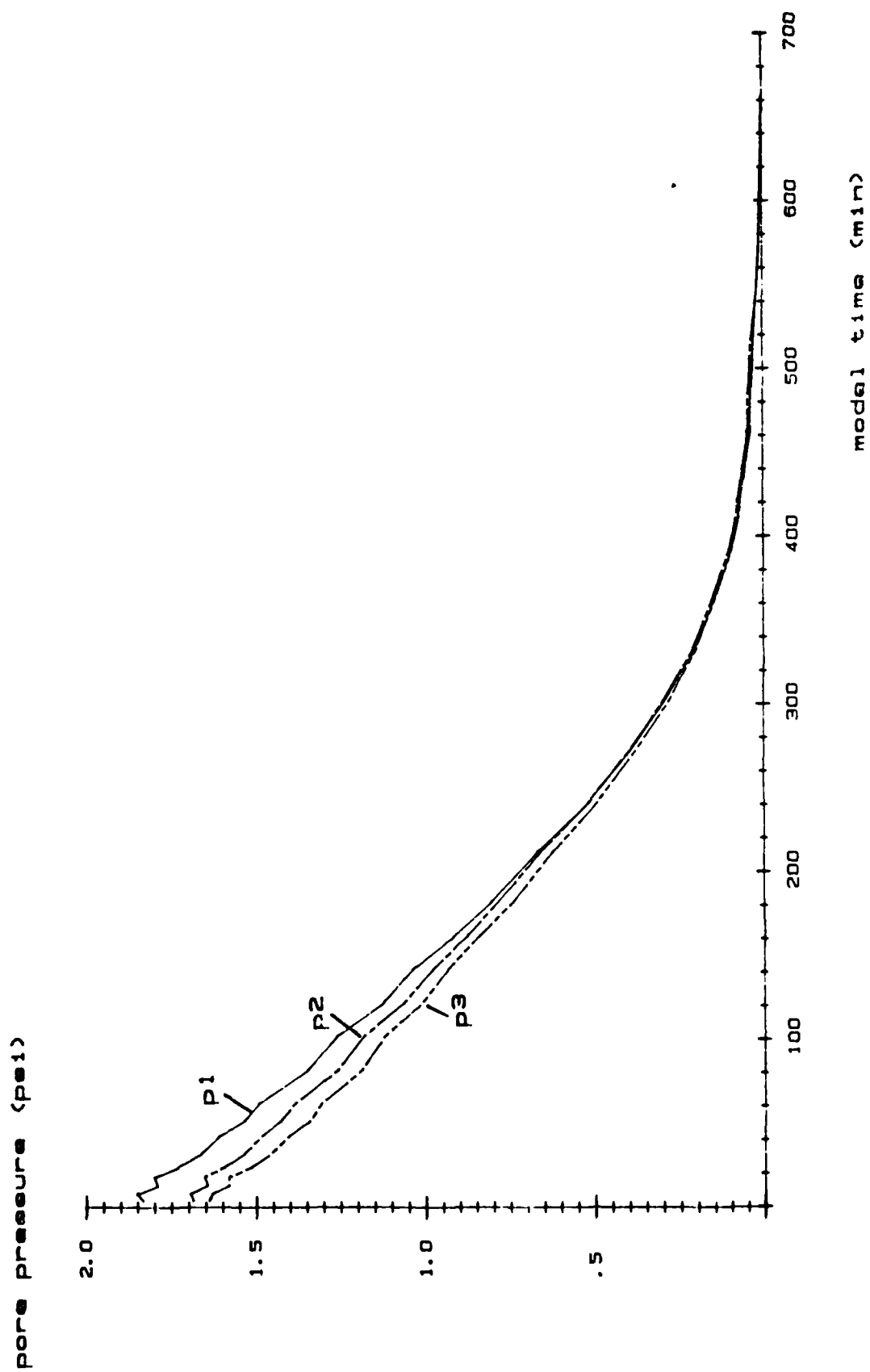


Fig. 1 - Pore pressure change with time

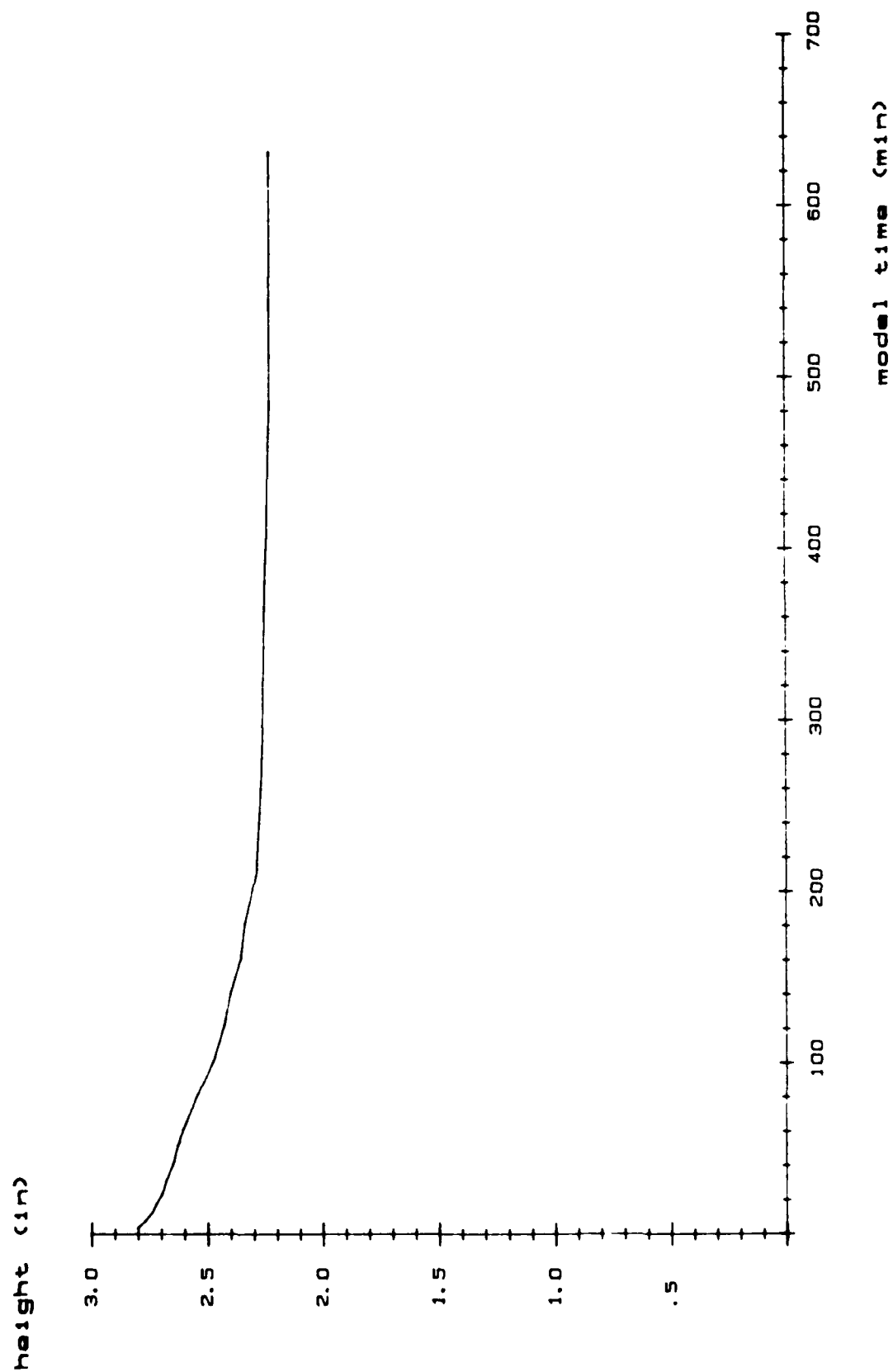


Fig. 2 - Height change with time (scale 1)

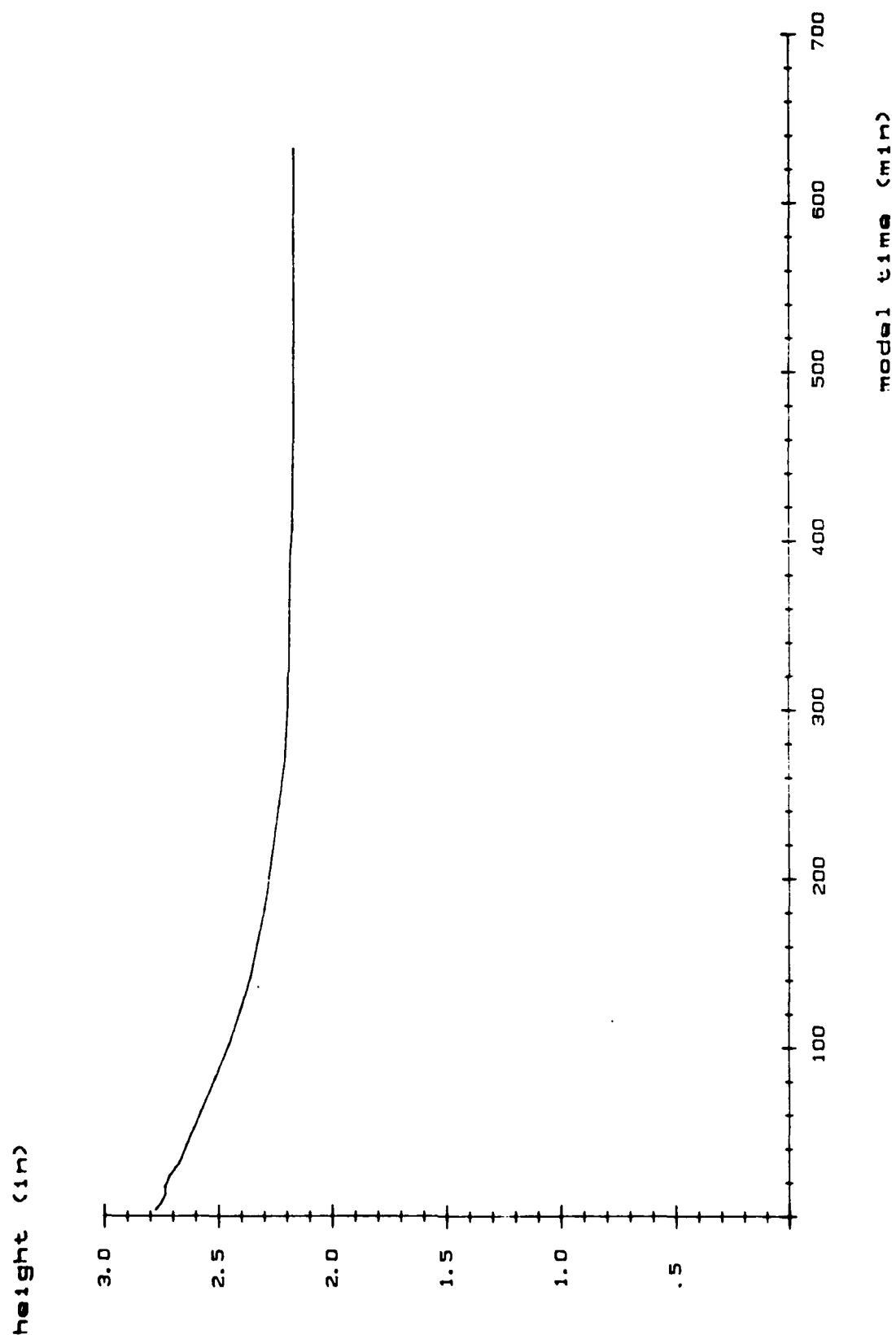


Fig. 3 - Height change with time (scale 2)

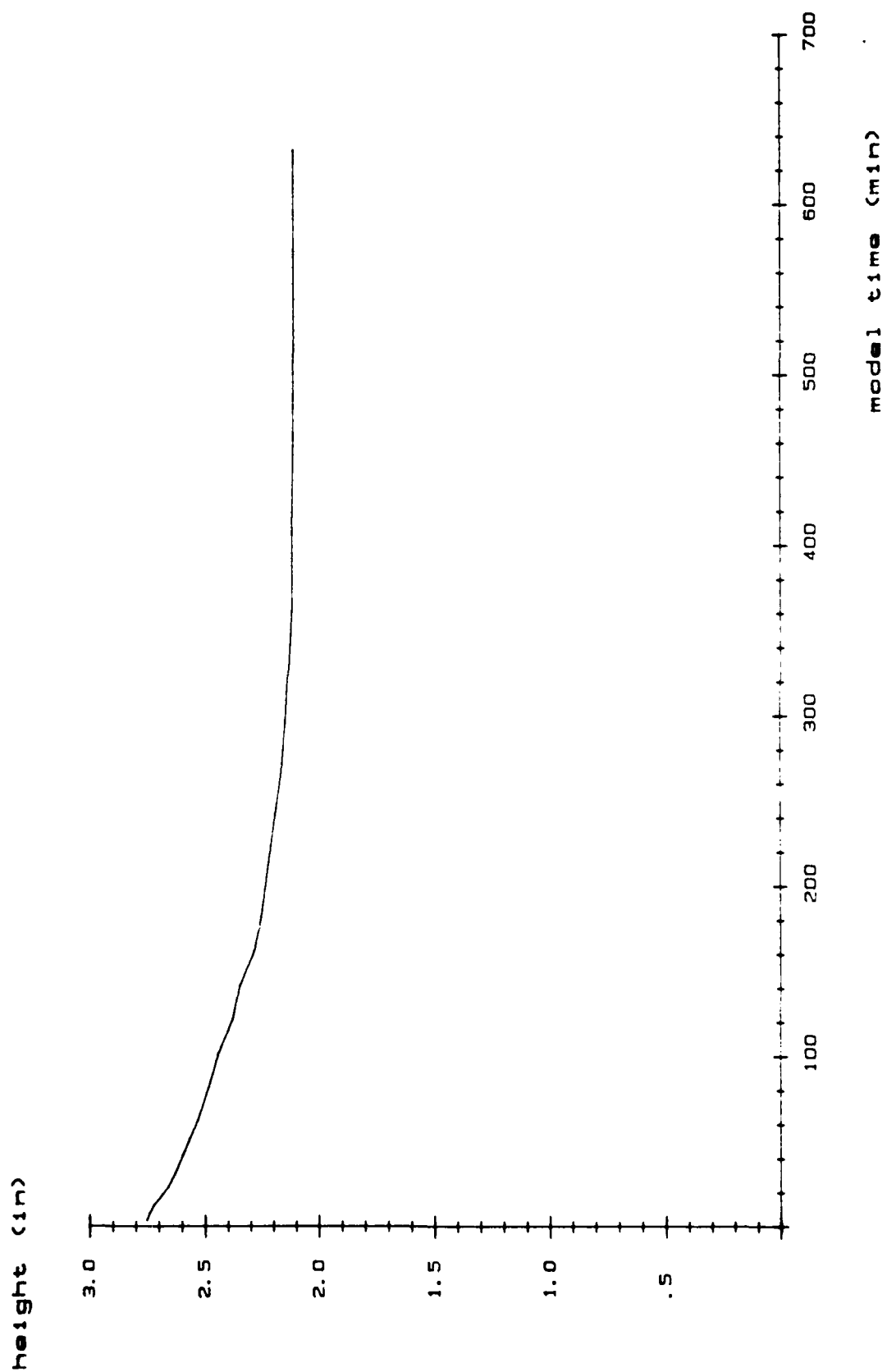


Fig. 4 - Height change with time (scale 3)

height (in)

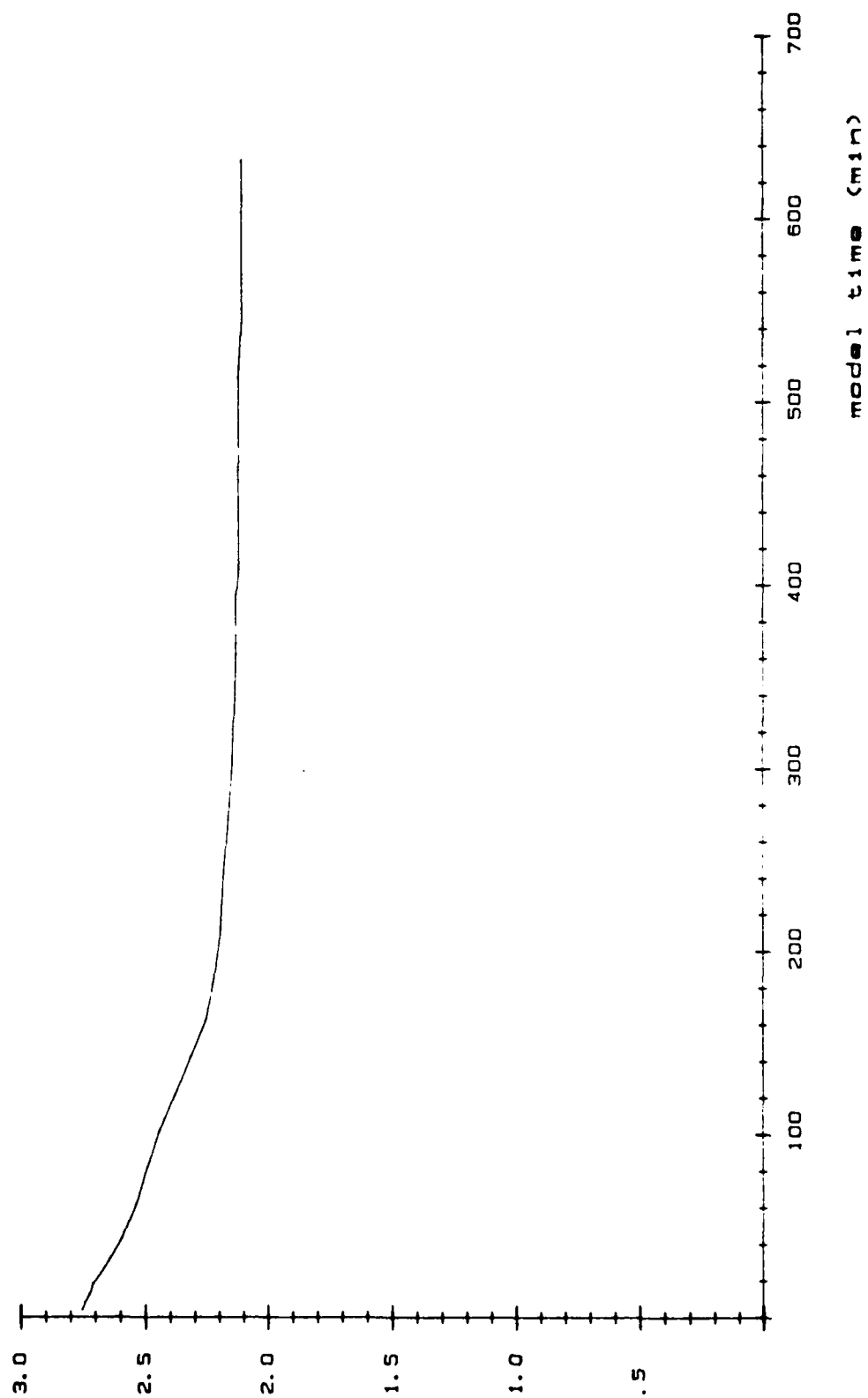


Fig. 5 - Height change with time (scale 4)

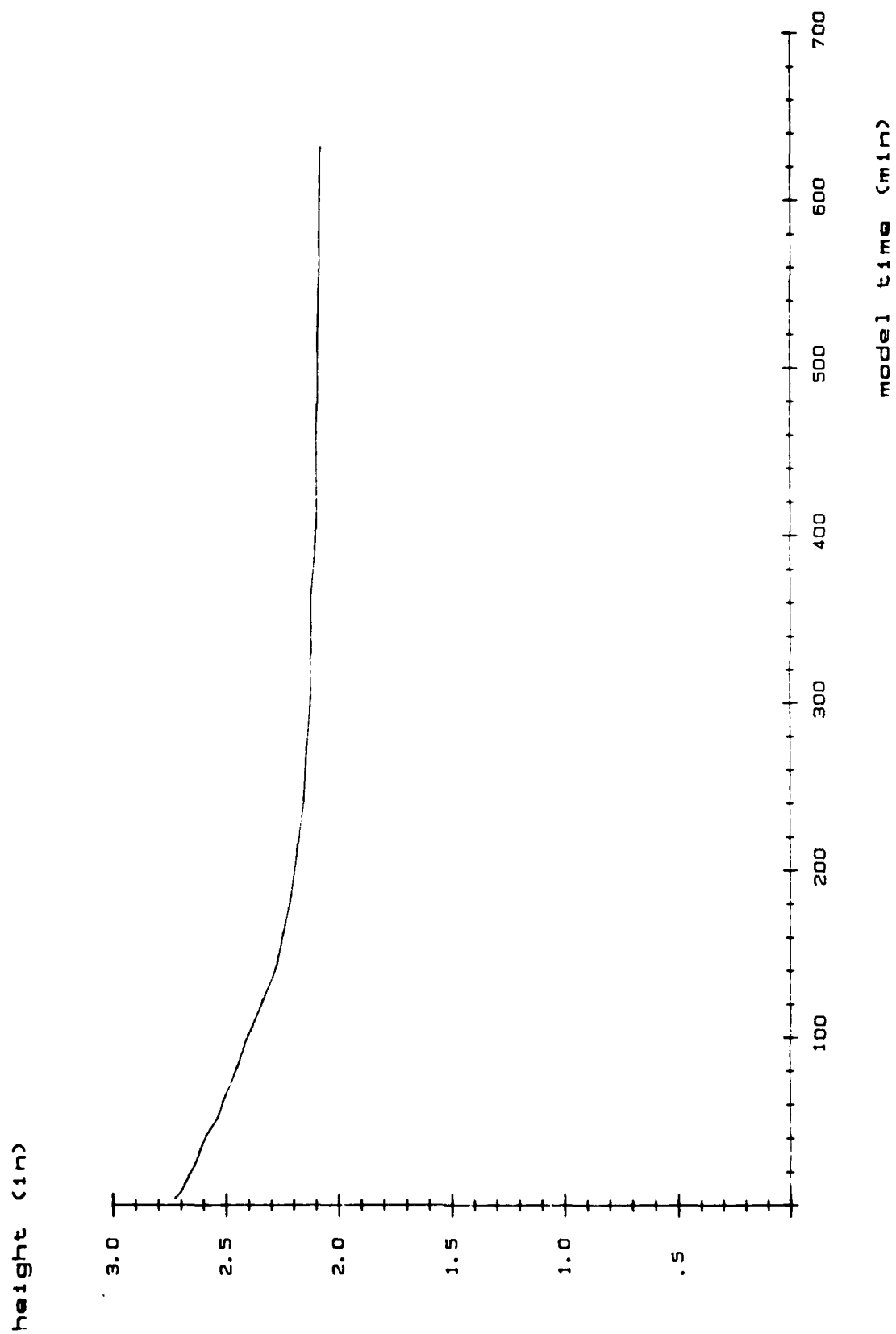


Fig. 6 - Height change with time (scale 5)

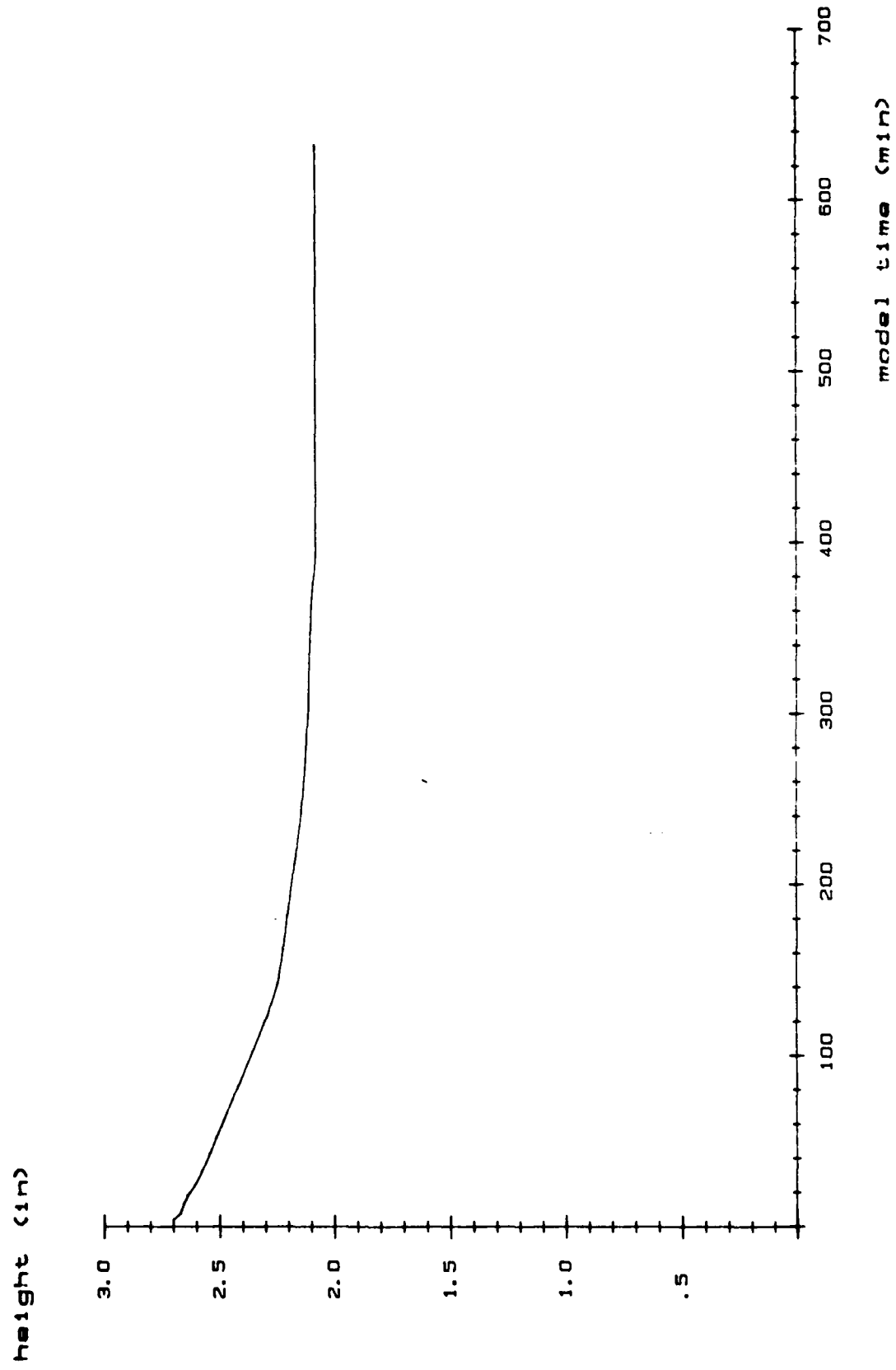


Fig. 7 - Height change with time (scale 8)

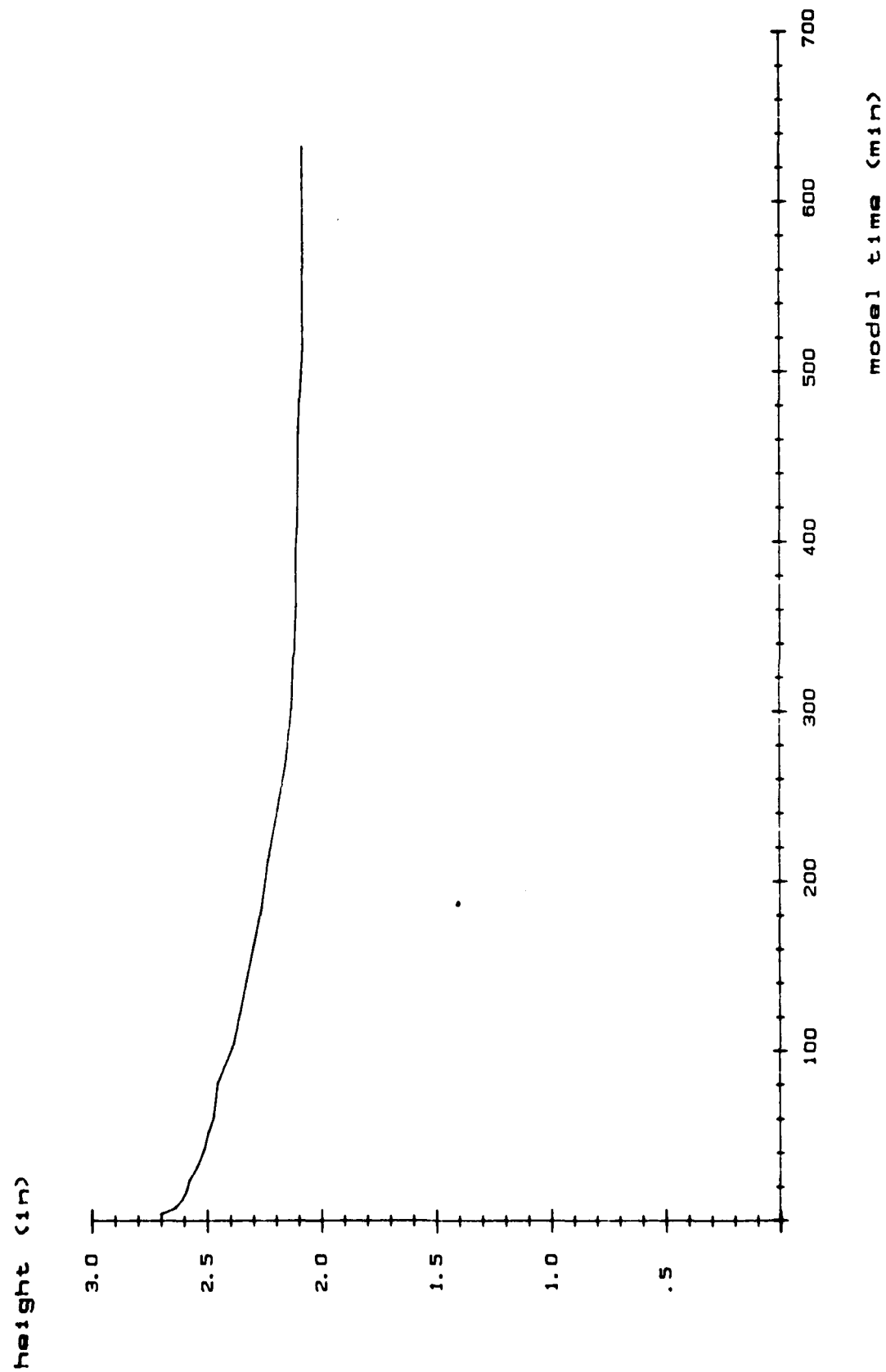


fig. 8 - Height change with time (scale 7)

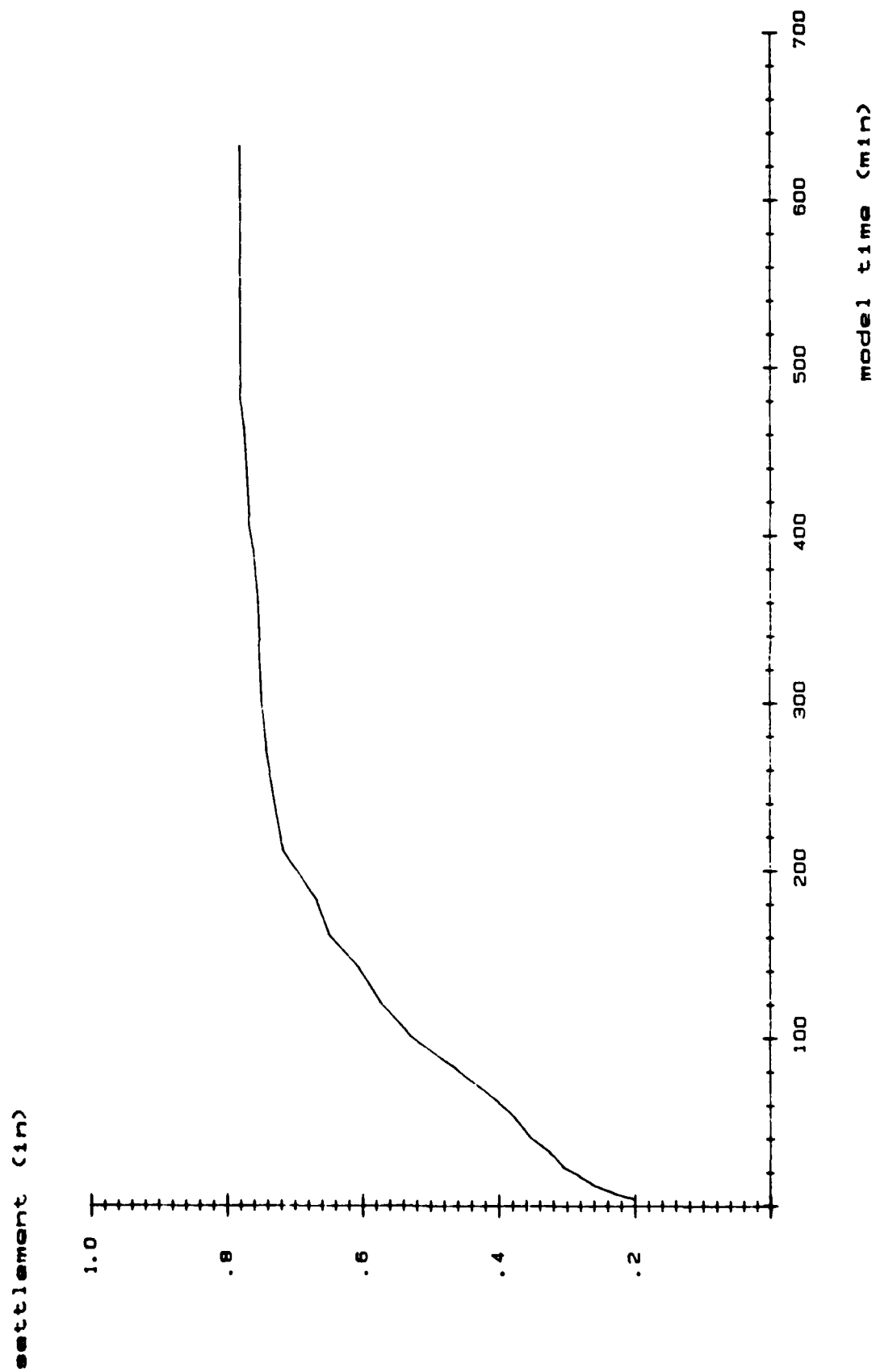


Fig.9 - Settlement with time (scale 1)

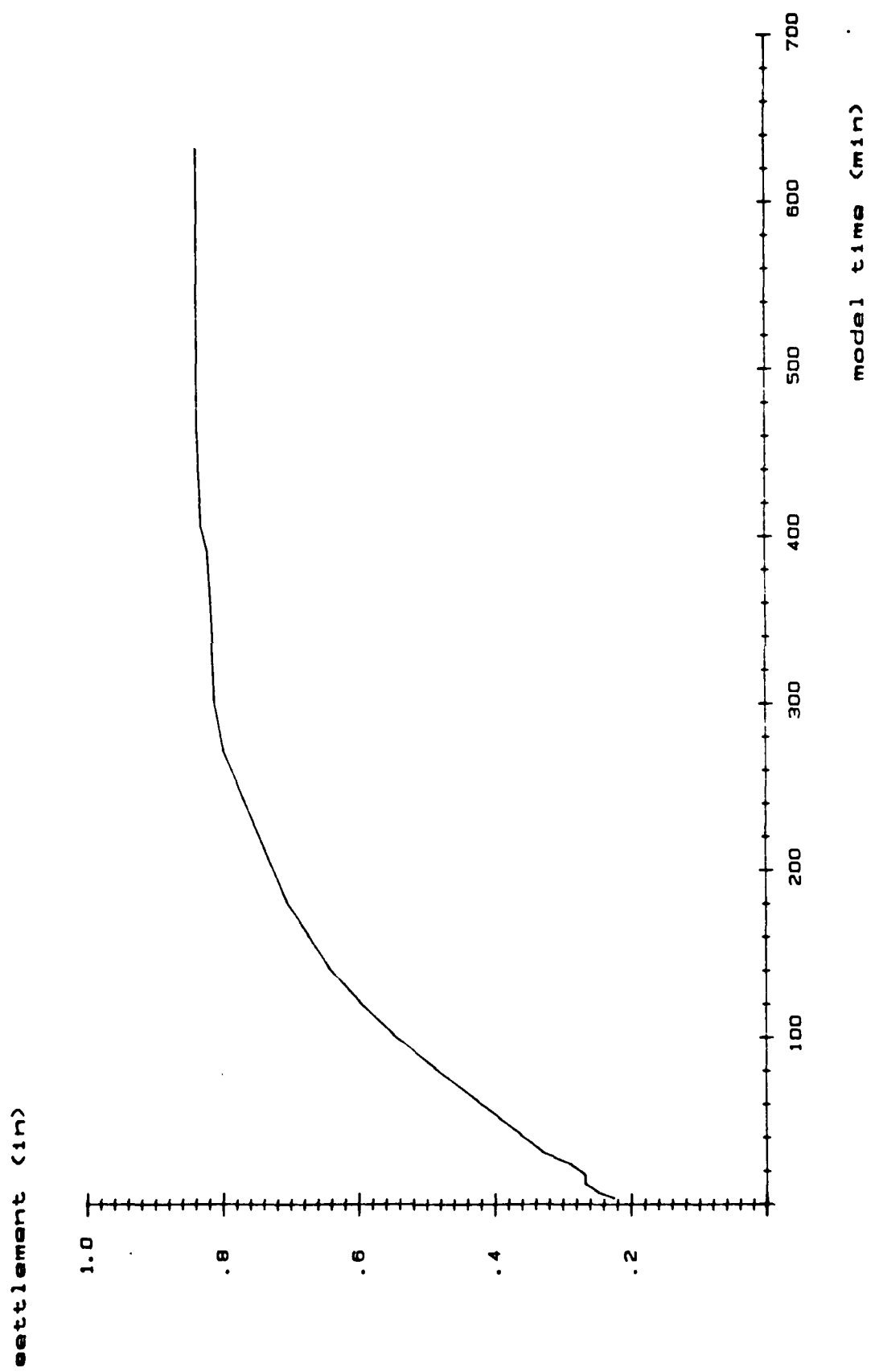


Fig. 10 - Settlement with time (scale 2)

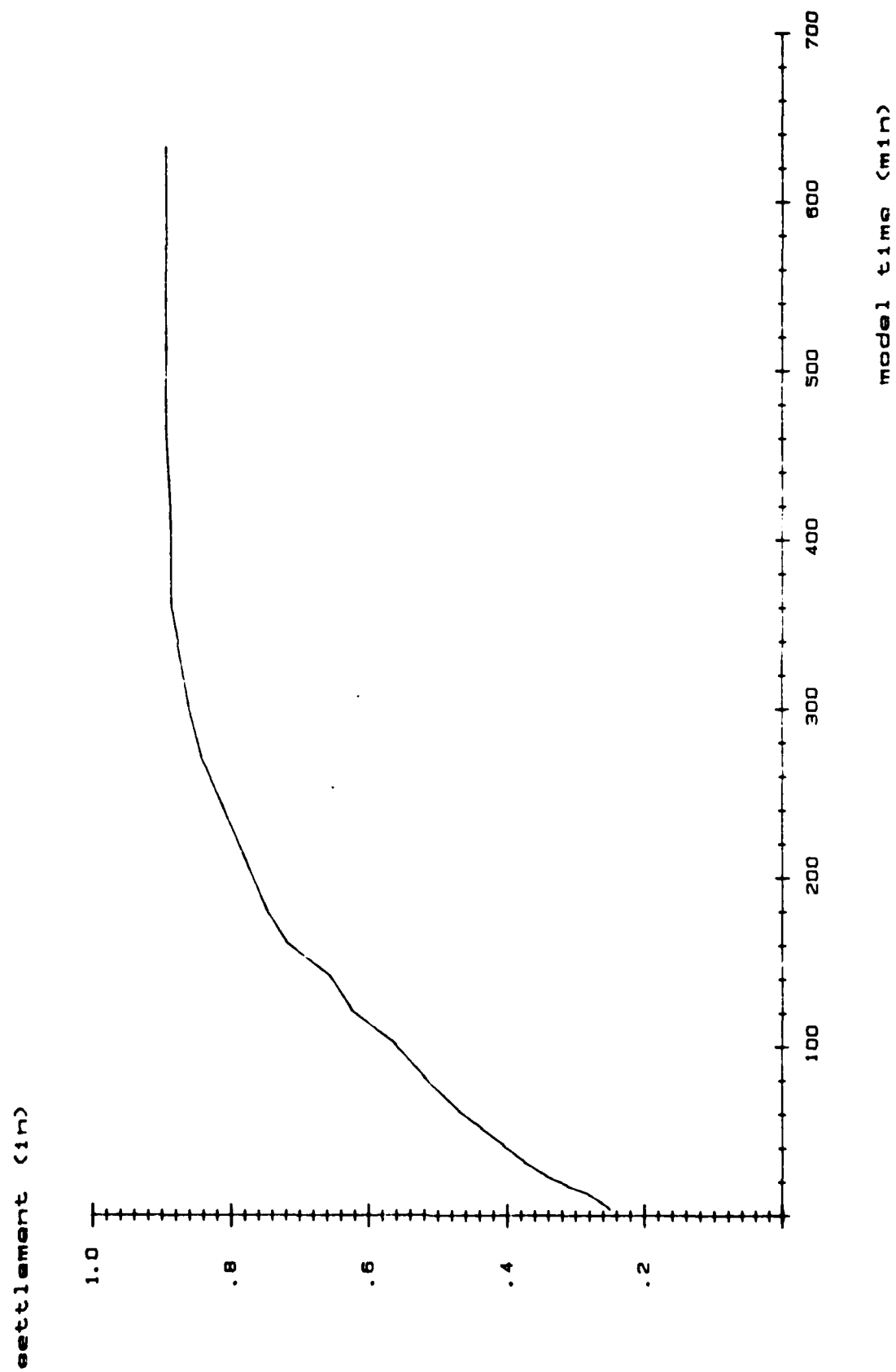


Fig. 11 - Settlement with time (scale 3)

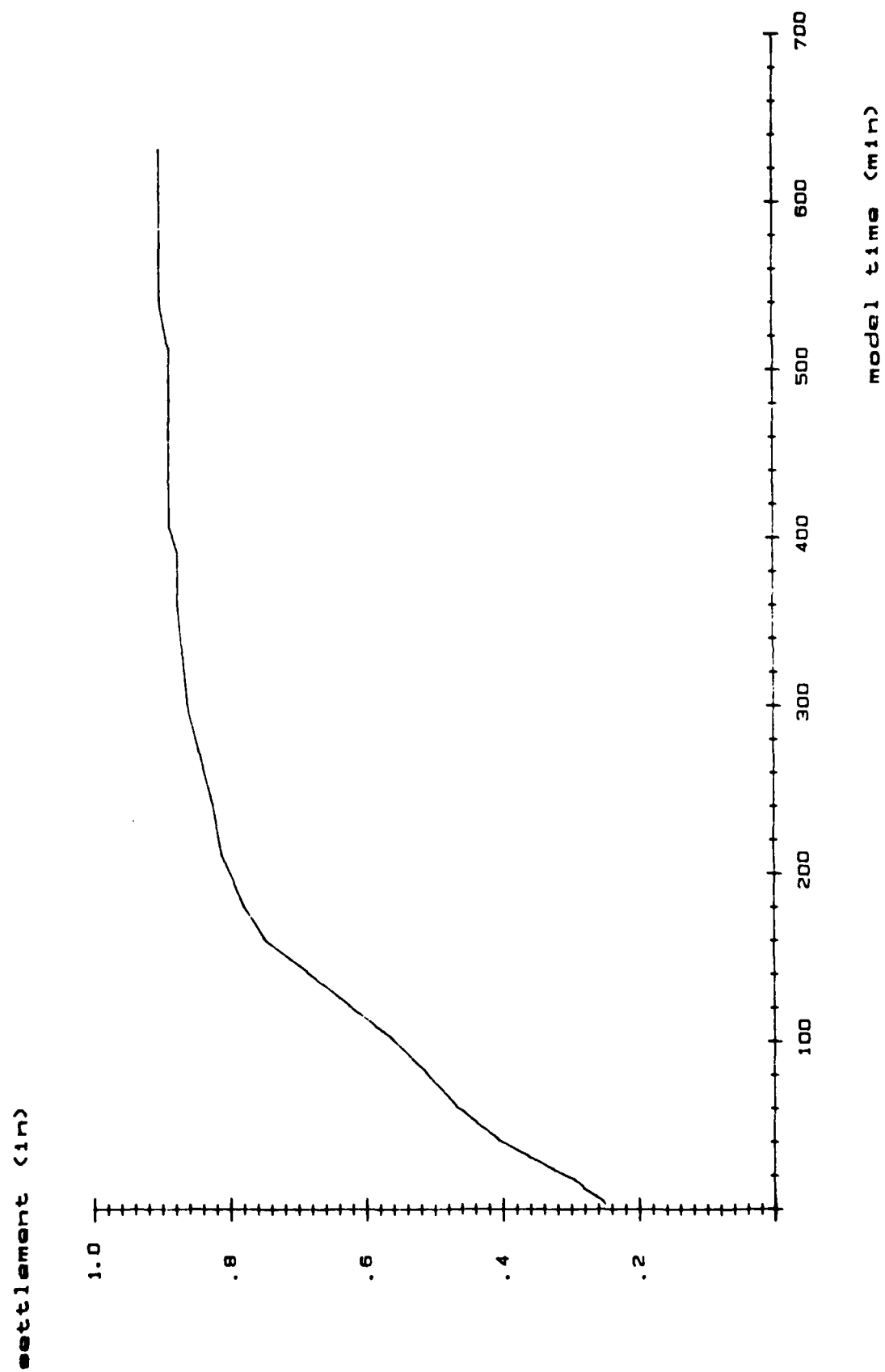


Fig. 12 - Settlement with time (scale 4)

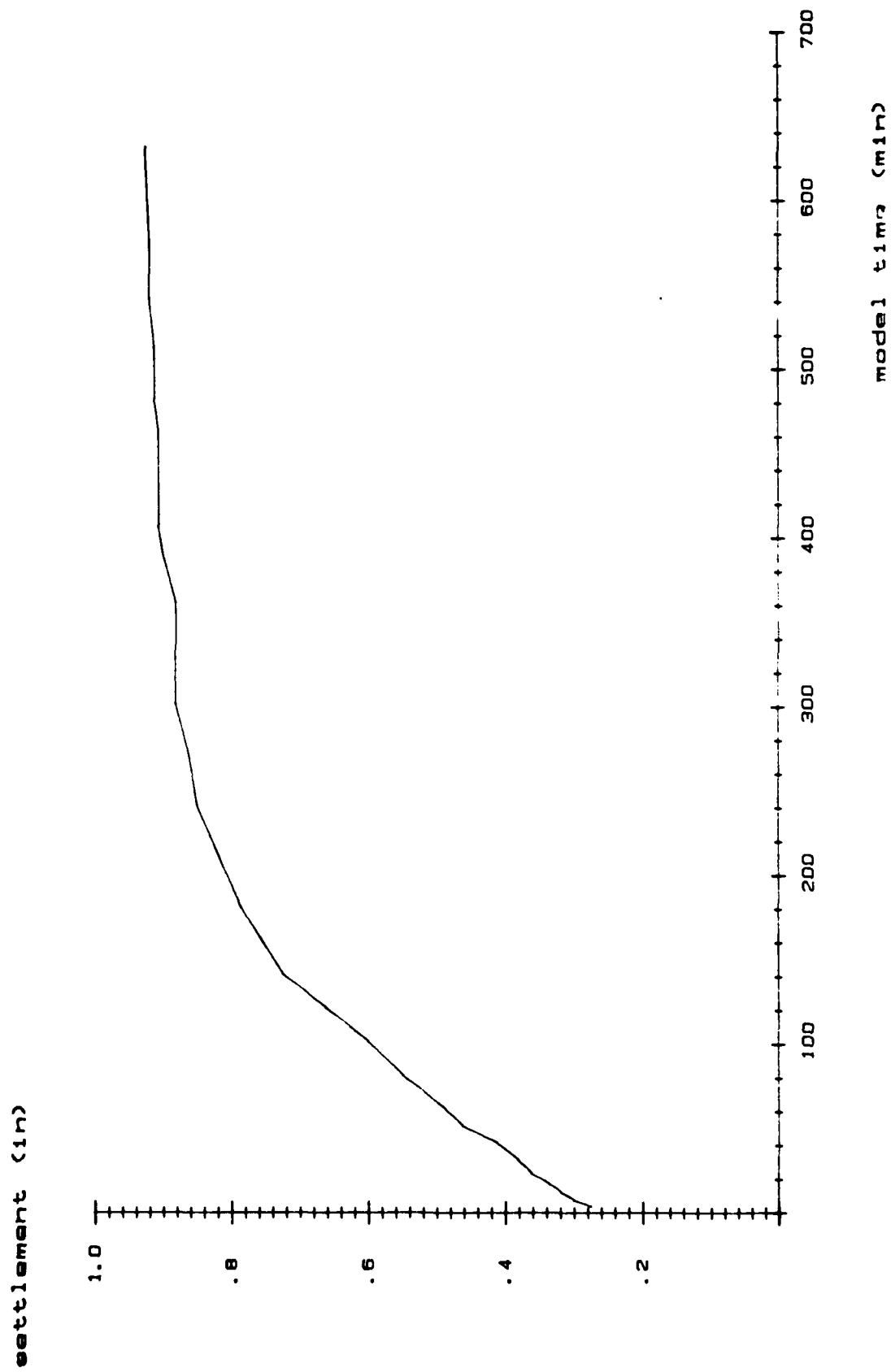


Fig. 13 - Settlement with time (scale 5)

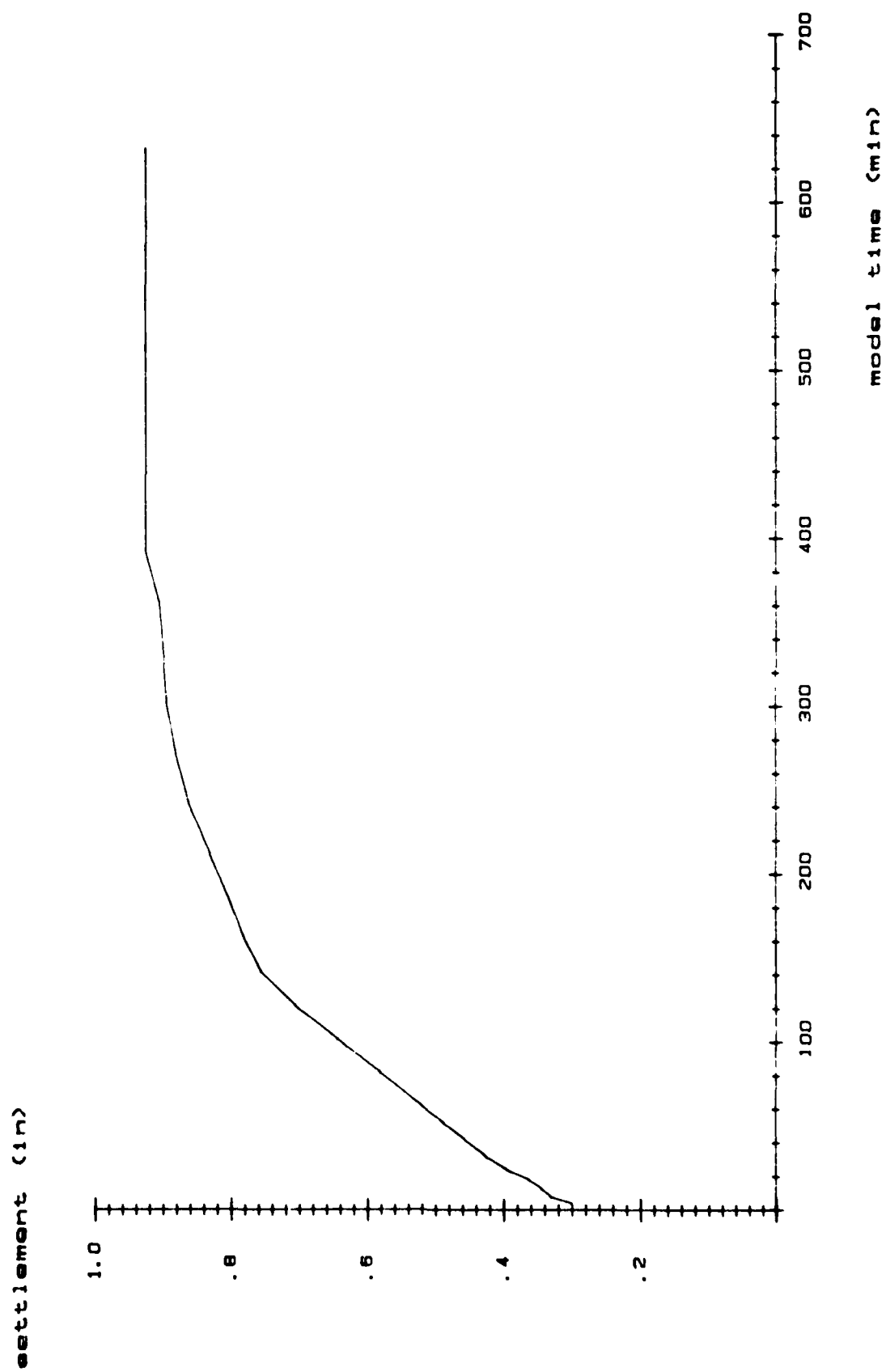


Fig. 14 -- Settlement with time (scale 6)

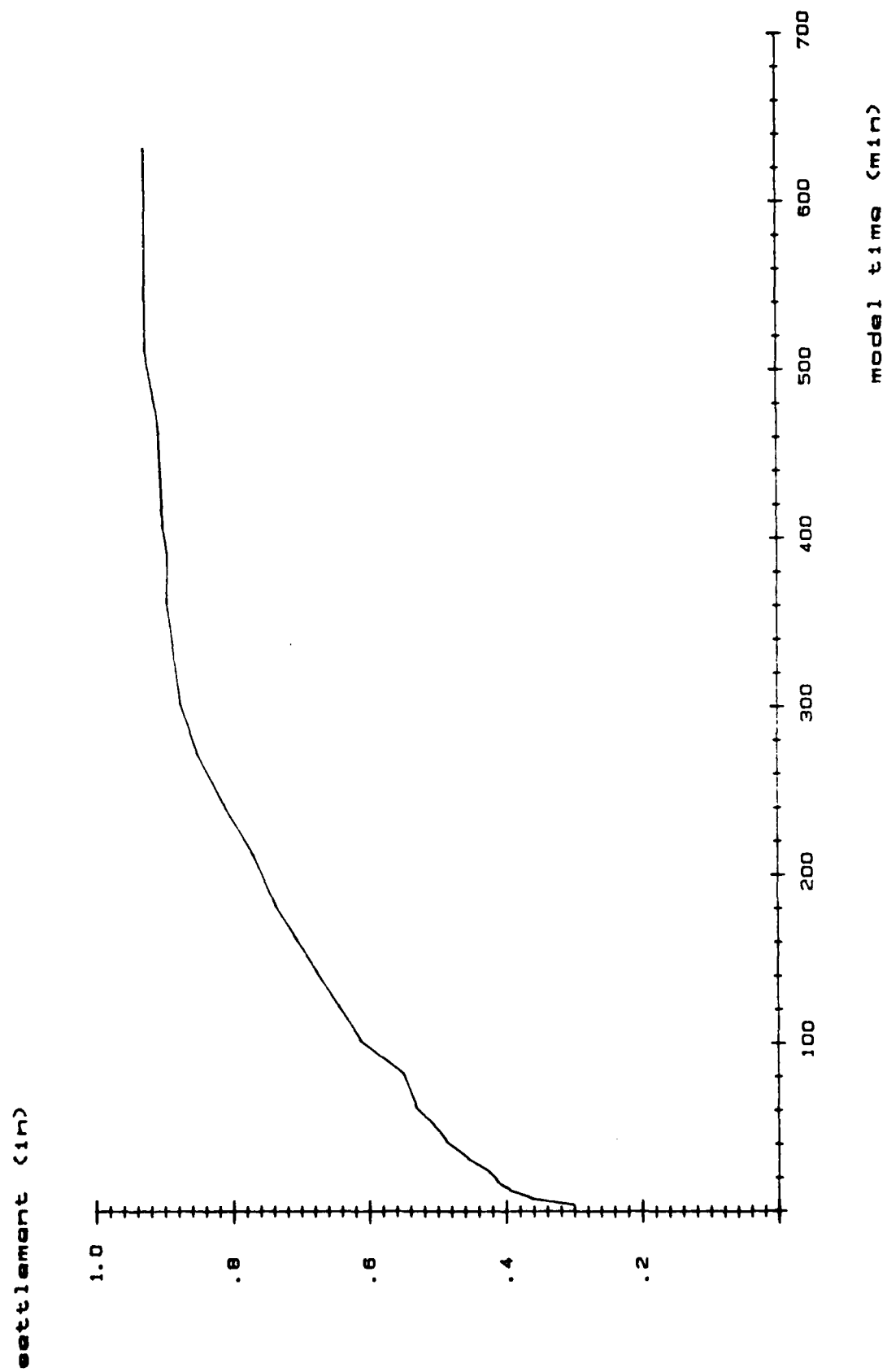


Fig. 15 - Settlement with time (scale 7)

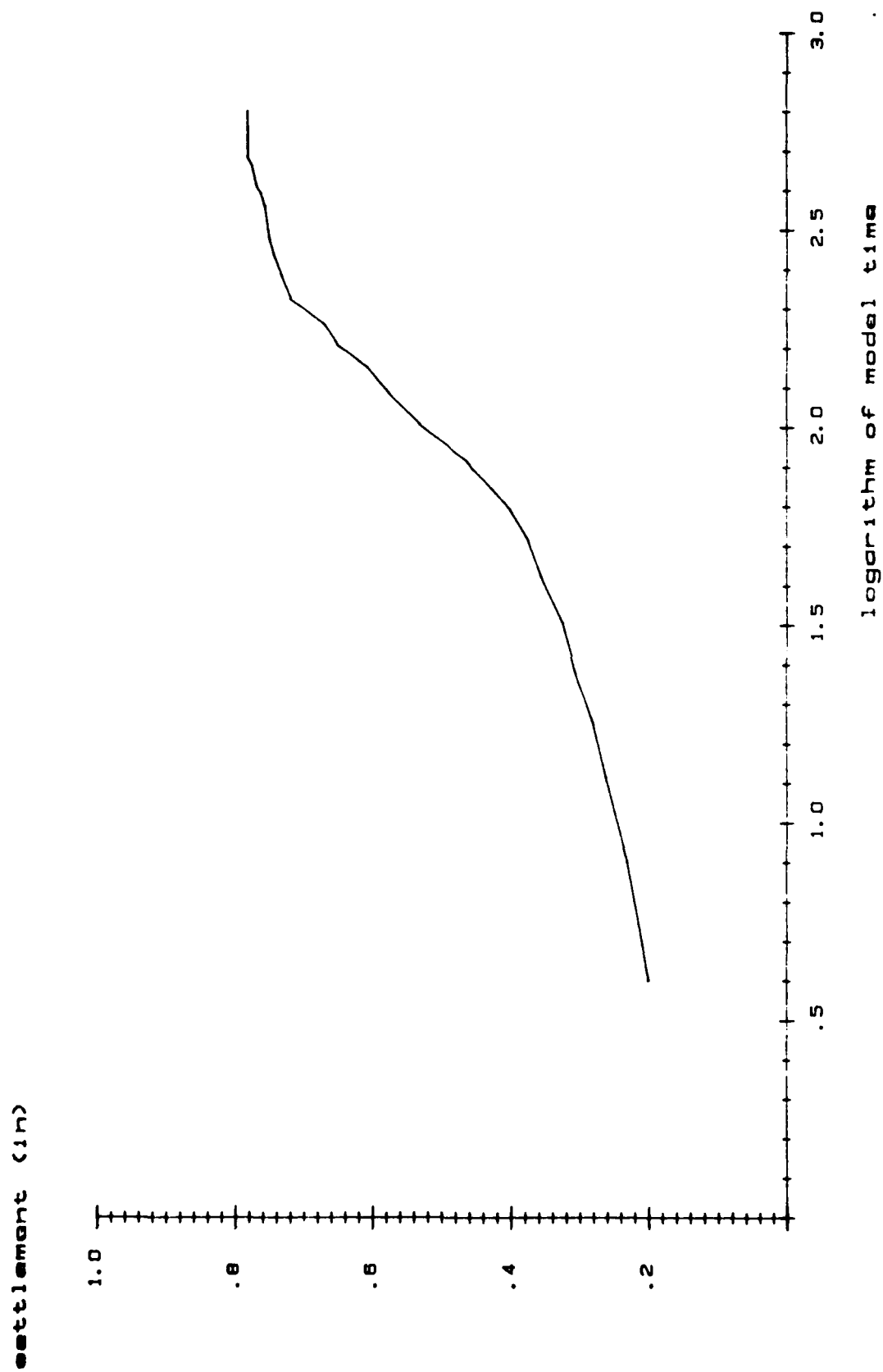


Fig. 16 - Settlement with logarithm of time (scale 1)

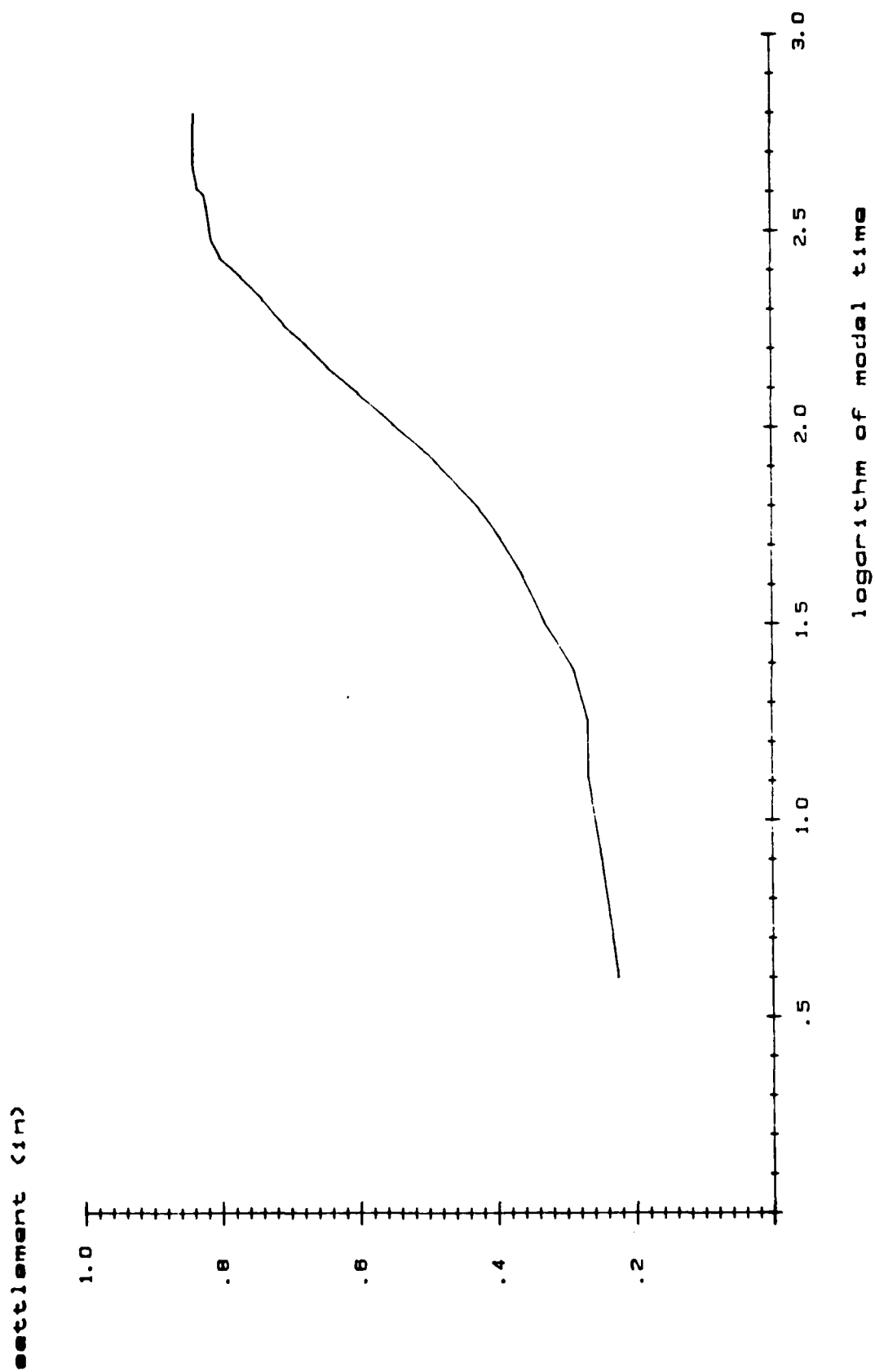


Fig. 17 - Settlement with logarithm of time (scale 2)

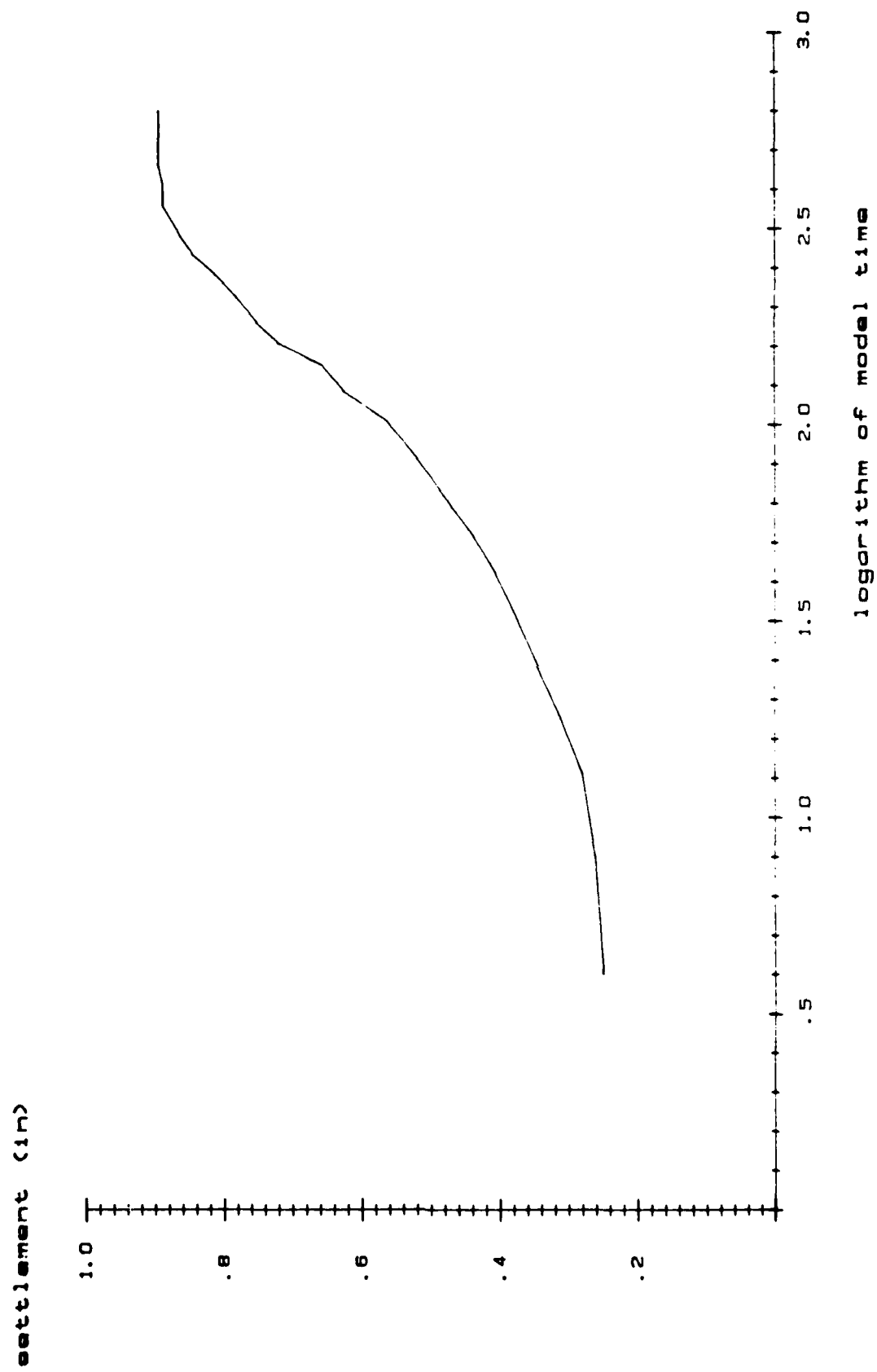
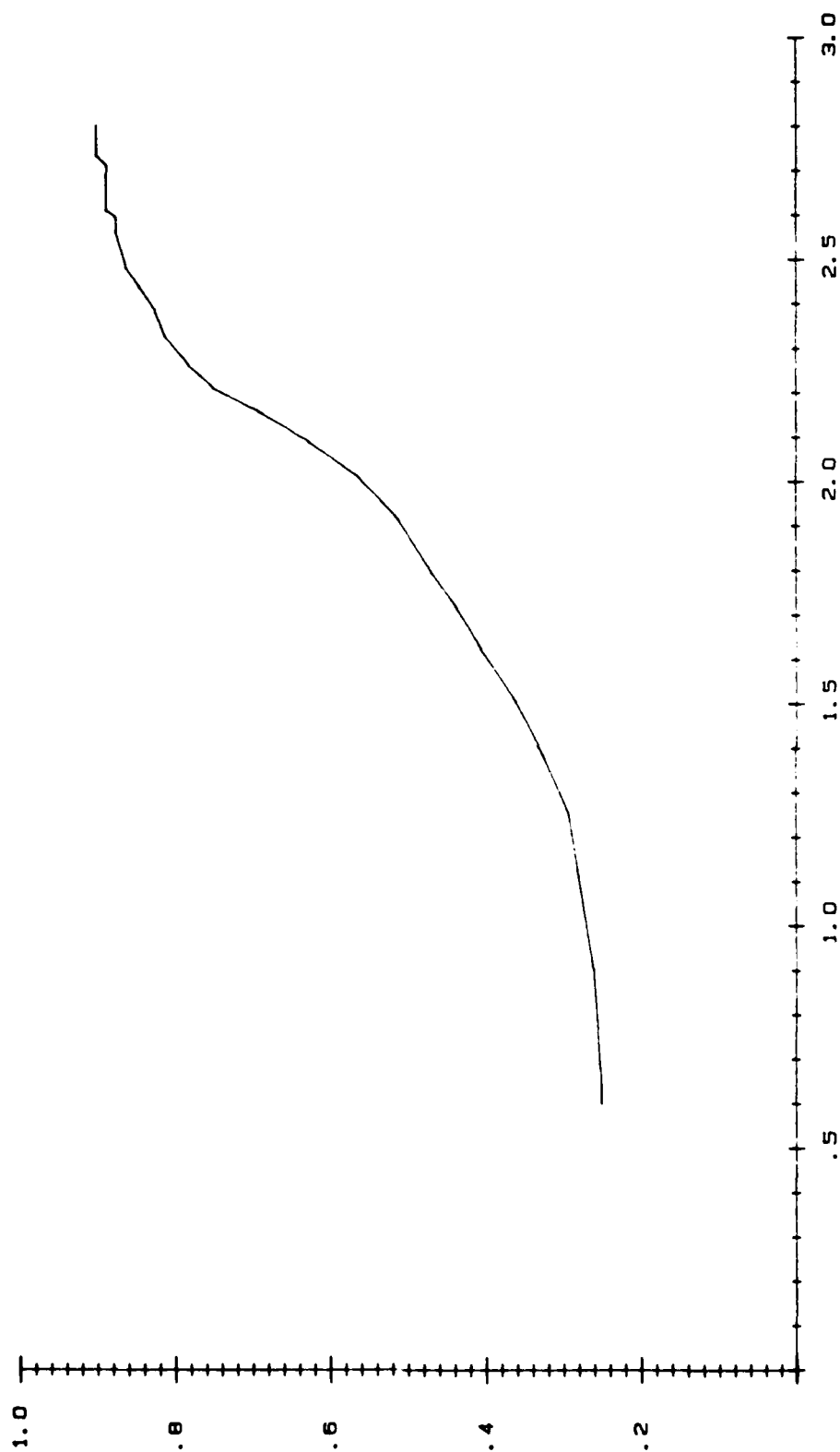


Fig. 18 - Settlement with logarithm of time (scale 3)

settlement (in)



logarithm of model time

Fig. 19 - Settlement with logarithm of time (scale 4)

settlement (in)

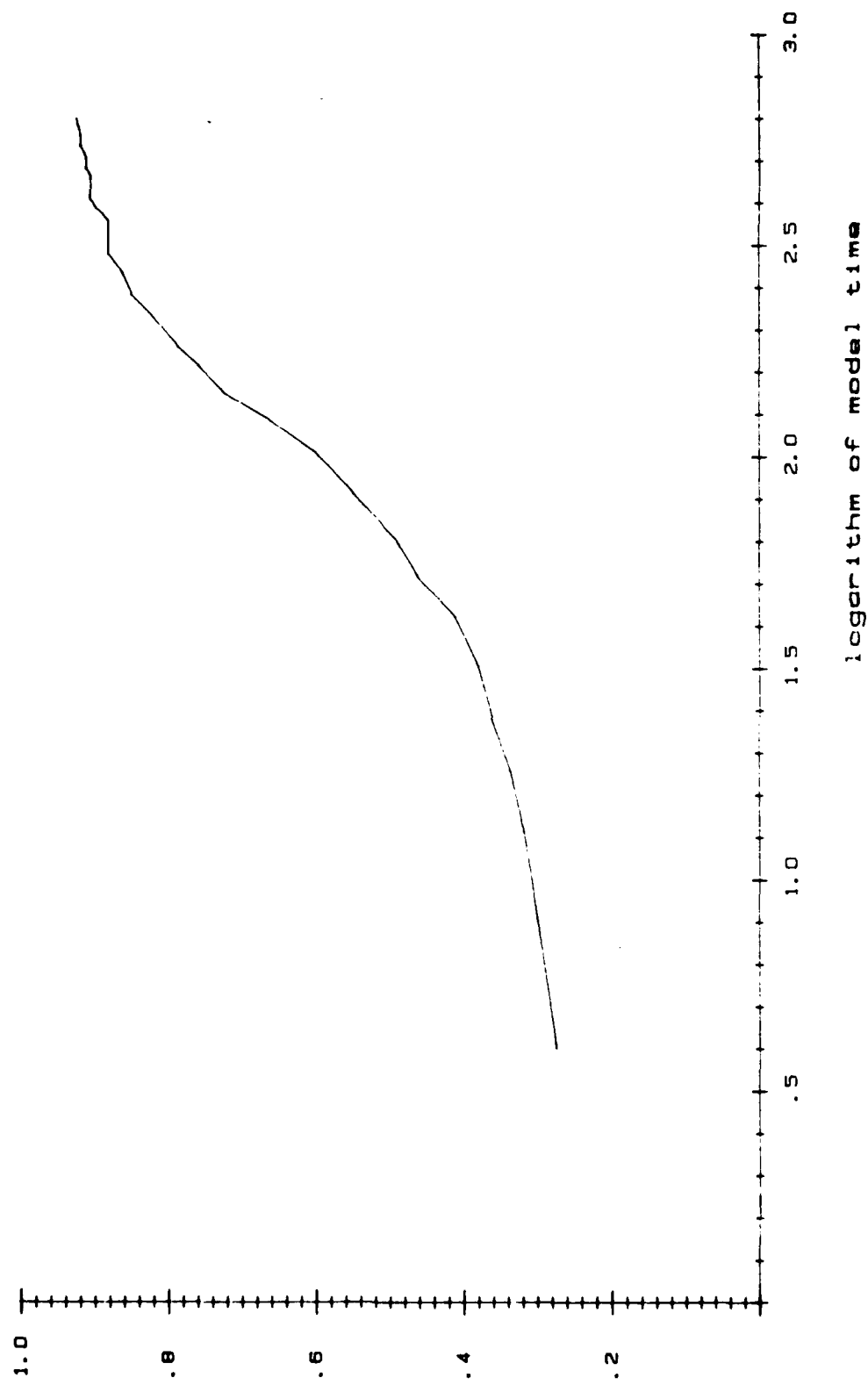


Fig. 20 - Settlement with logarithm of time (scale 5)

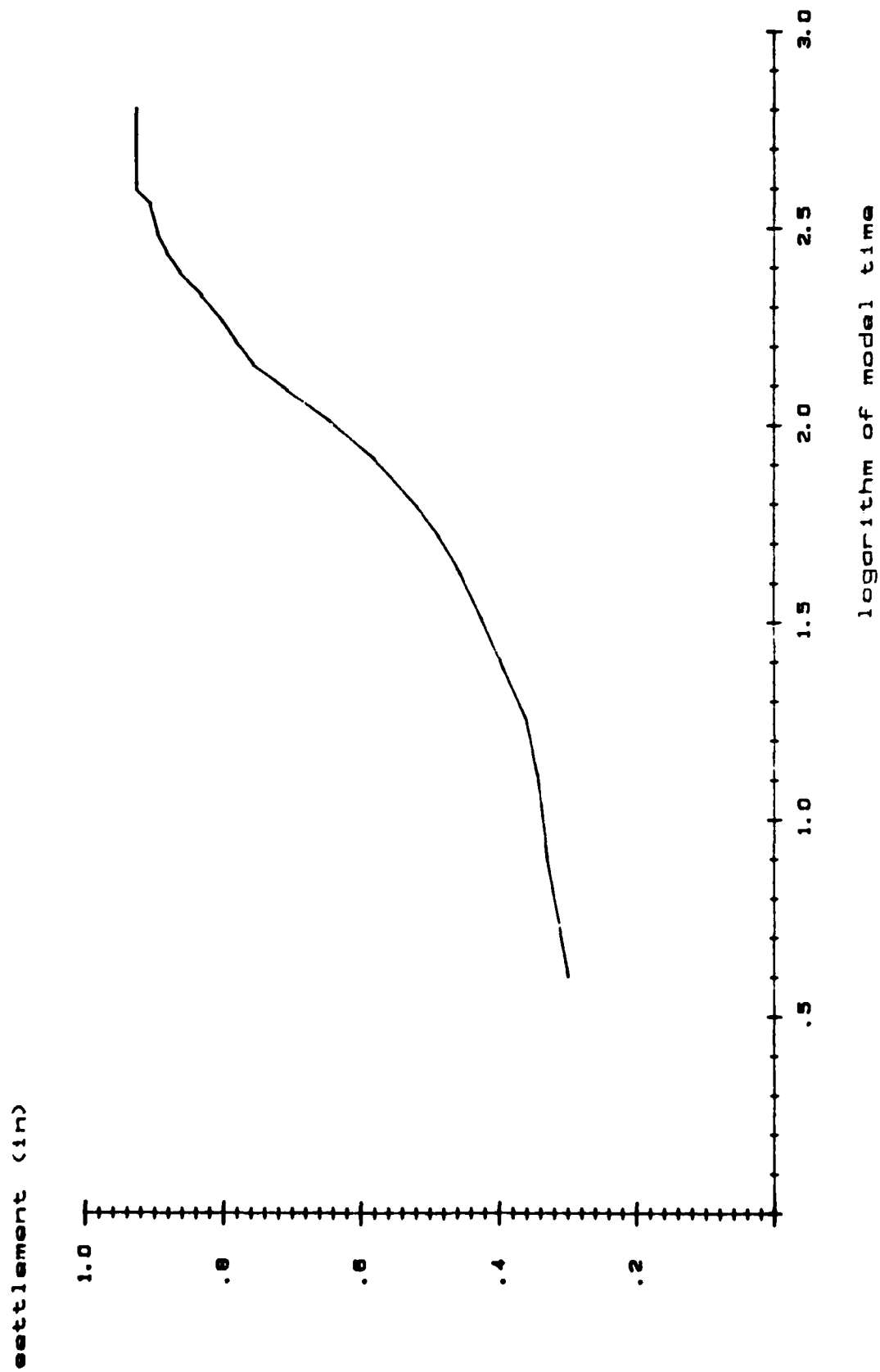


Fig. 21 -Settlement with logarithm of time (scale 6)

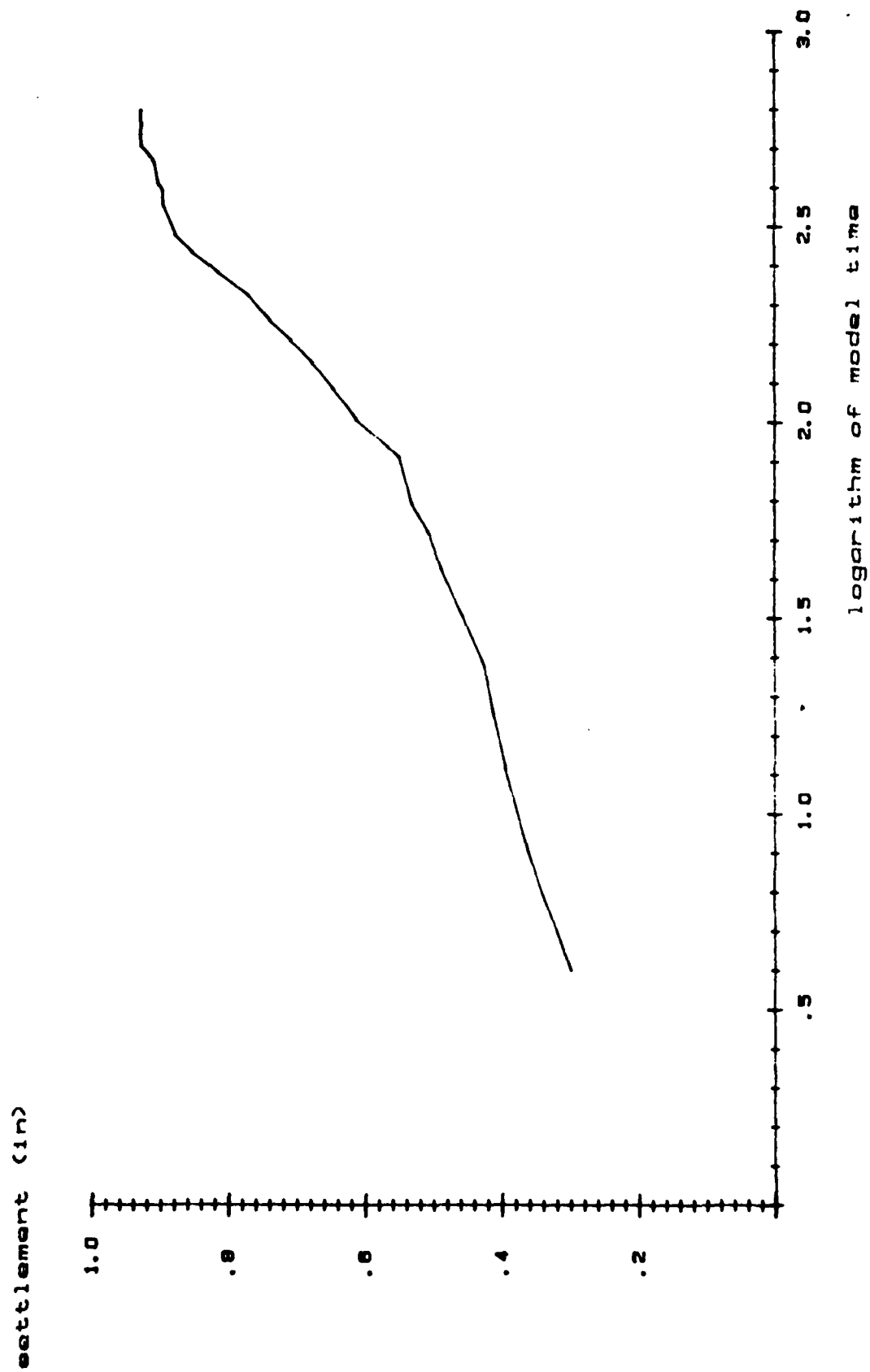


Fig. 22 - Settlement with logarithm of time (scale 7)

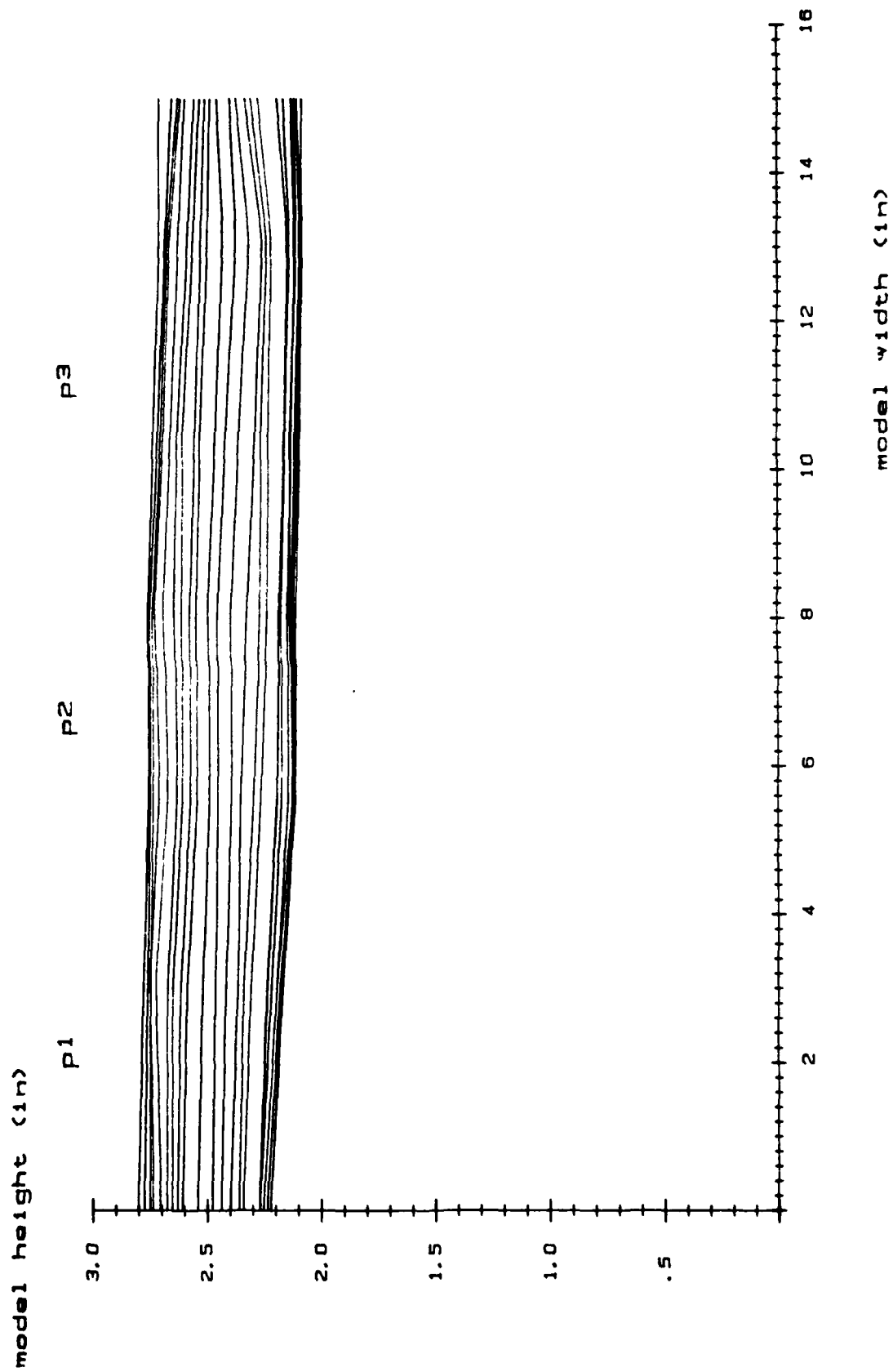
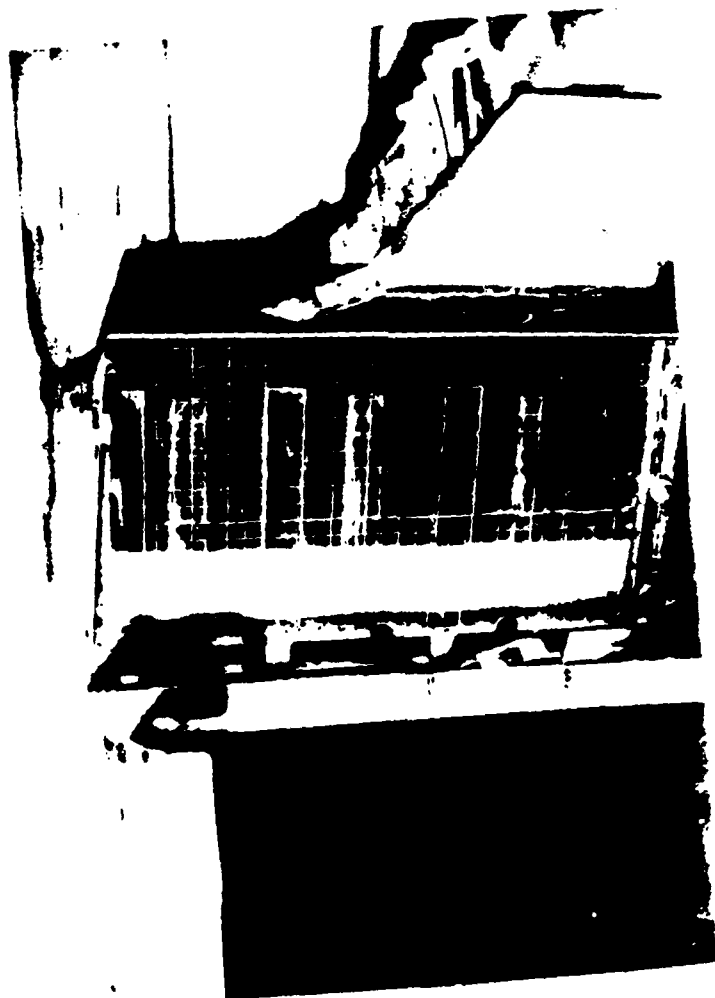


Fig.23 - Surface contour at different times

Figure 23*A*



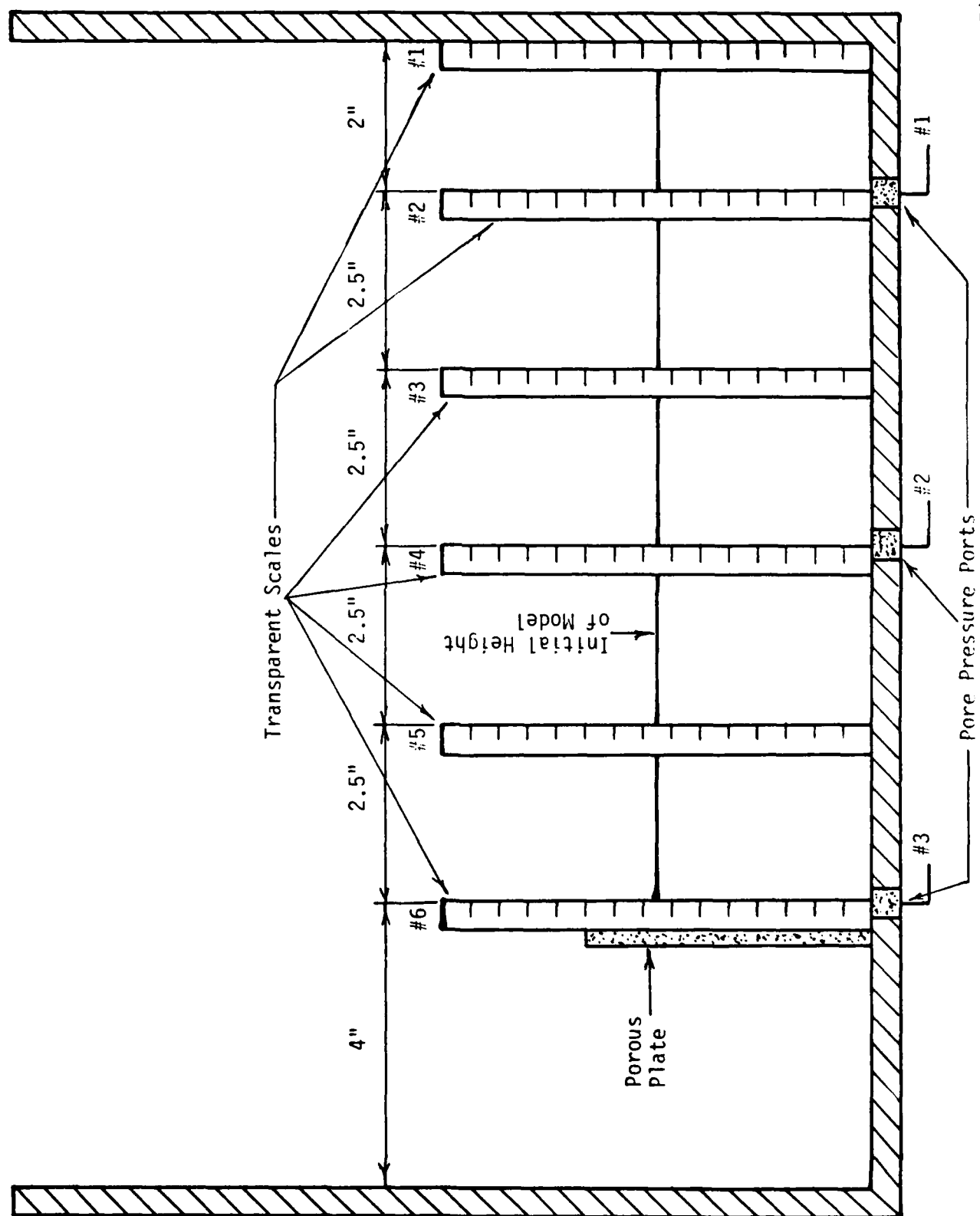


Figure 24

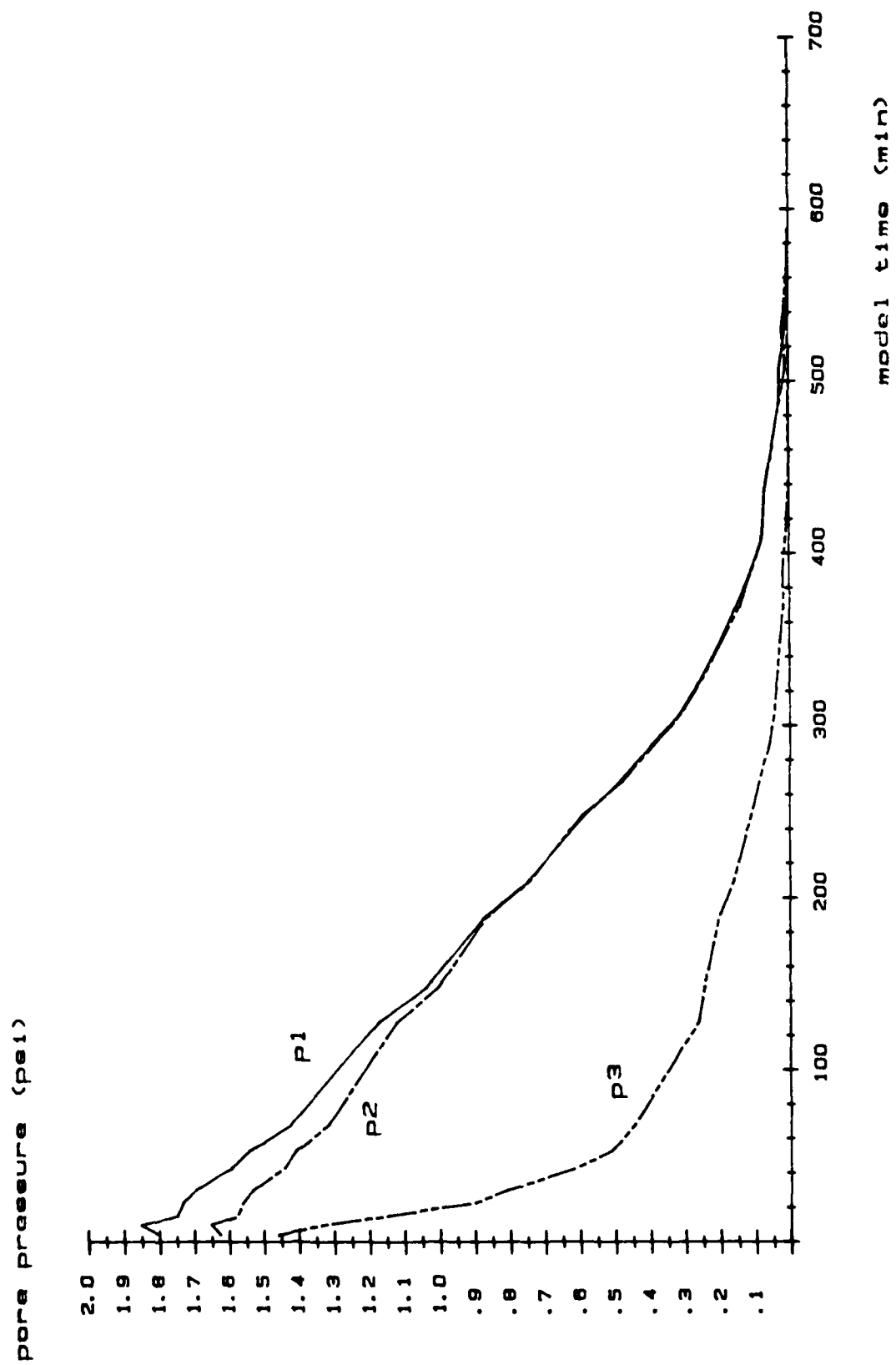
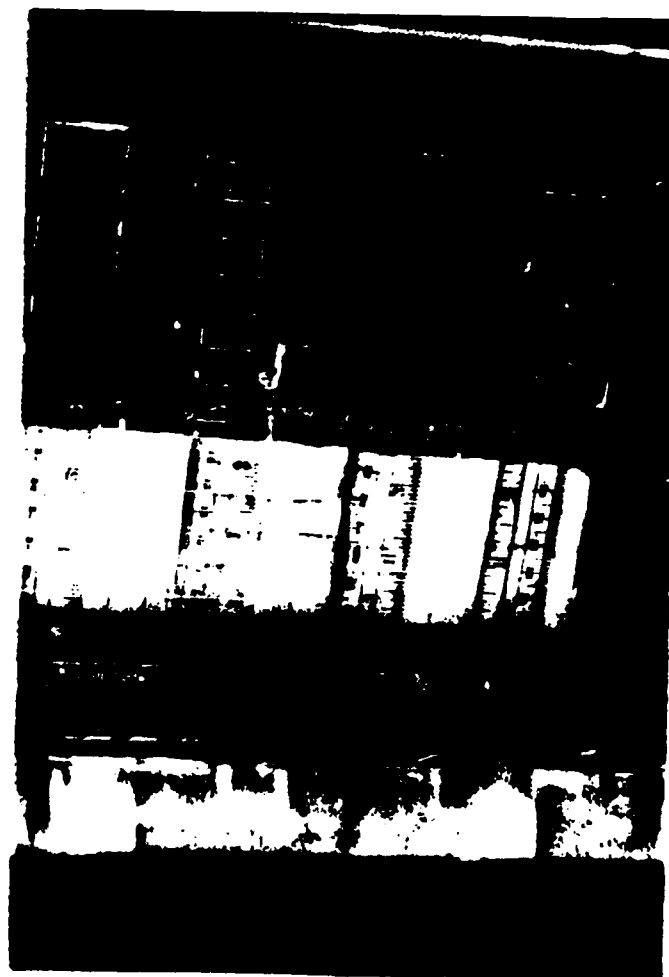


Fig. 25 ... Pore pressure change with time

Figure 26



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